Claims

[c1] 1. A method for synthesizing a nucleic acid probe array, comprising the steps of:

(1) providing a substrate;

(2) providing nucleotides or nucleosides that are protected by a photo-protecting group;

(3) directing a light beam onto a plurality of optical transfer elements;

(4) selectively switching the optical transfer elements between substantially light-passing and substantially light-not-passing states in response to gating data;

(5) disposing light passed through optical transfer elements in the substantially light-passing state onto the substrate to provide a reactive group; and

(6) contacting the nucleotides or nucleosides with the reactive group.

[c2] 2. The method of claim 1 , wherein:

light passed through at least one optical transfer element in the substantially light-passing state strikes a first set of selected portions of the substrate, thereby activating the first set of selected portions.

[c3] 3. The method of claim 1 , wherein:

the light beam includes ultra-violet light.

[c4] 4. The method of claim 1 , wherein:

the optical transfer elements include an optical fiber.

[c5] 5. A method for synthesizing one or more arrays of biological probes on one or more substrates, comprising the steps of:

(1) directing a light beam onto one or more optical transfer elements;

(2) selectively switching the optical transfer elements between substantially light-passing and substantially light-not-passing states in response to gating data; and

(3) disposing light passed through optical transfer elements in the substantially light-passing state onto the one or more substrates.

[c6] 6. The method of claim 5 , further comprising the step of:

(4) activating selected portions of the substrate responsive to step (3).

[c7] 7. The method of claim 6, wherein:
light passed through at least one optical transfer element in the substantially light-passing state strikes a first set of selected portions of the substrate, thereby activating the first set of selected portions.

[c8] 8. The method of claim 7, further comprising the step of:
(5) providing linker molecules on the substrate, wherein the linker molecules include a reactive functional group protected with a photo-removable protective group; and
wherein step (4) includes exposing the photo-removable protective groups to light in the first set of selected portions of the substrate, thereby removing the photo-removable protective groups from the linker molecules and exposing the reactive functional groups in the first set of selected portions.

[c9] 9. The method of claim 8, further comprising the step of:
(6) contacting the exposed reactive functional groups with first monomers capable of reacting with the exposed reactive functional groups.

[c10] 10. The method of claim 9, wherein:
the first monomers include a nucleotide, nucleoside, amino acid, or saccharide.

[c11] 11. The method of claim 9, wherein:
the first monomers include a reactive functional group protected with a photo-removable protective group.

[c12] 12. The method of claim 11, wherein:
light passed through at least one optical transfer element in the substantially light-passing state strikes a second set of selected portions of the substrate, which may be the same as or different than the first set of selected portions, thereby activating the second set of selected portions; and wherein the method further includes the step of
(7) contacting exposed reactive functional groups of the linker molecules or of the first monomers with a second monomer, which may be the same or different than the first monomer, capable of reacting with exposed reactive functional

groups of the linker molecules or of the first monomer and having a reactive functional group protected with a photo-removable protective group.

[c13] 13. The method of claim 5 , further comprising the step of:
(4) deactivating selected portions of the substrate responsive to step (3).

[c14] 14. The method of claim 13 , wherein:
light passed through at least one optical transfer element in the substantially light-passing state strikes a portion of the substrate, thereby deactivating the selected portion.

[c15] 15. An apparatus, comprising:
a plurality of optical transfer elements;
a light beam source that provides a light beam to the optical transfer elements;
a plurality of gates constructed and arranged to selectively switch the optical transfer elements between substantially light-passing and substantially light-not-passing states; and
one or more biological probe array substrates disposed to be capable of receiving light passed through the optical transfer elements in the substantially light-passing states.

[c16] 16. The apparatus of claim 15 , wherein:
the light beam source includes an ultra-violet radiation source.

[c17] 17. The apparatus of claim 15 , wherein:
the light beam source includes an integrated parabolic or ellipsoidal high intensity radiation source.

[c18] 18. The apparatus of claim 15 , wherein:
the light beam source provides a collimated light beam.

[c19] 19. The apparatus of claim 15 , wherein:
the light beam source includes a filter capable of selectively passing light having a wavelength of approximately 365 nanometers.

[c20] 20. The apparatus of claim 15 , wherein:
the light beam source includes one or more of the group of optical elements

consisting of a lens, mirror, shutter, or optical integrator.

[c21] 21. The apparatus of claim 15 , wherein:
the optical transfer elements comprise a single optical fiber, one or more segments of single optical fibers, a bundle of optical fibers, one or more segments of bundles of optical fibers, or one or more optical gates.

[c22] 22. The apparatus of claim 15 , wherein:
one or more of the plurality of optical transfer elements comprises first and second segments, each having an end optically coupled to a gate.

[c23] 23. The apparatus of claim 15 , wherein:
one or more of the plurality of optical transfer elements includes a tapered portion.

[c24] 24. The apparatus of claim 15 , wherein:
the gates include addressable gates.

[c25] 25. The apparatus of claim 15 , wherein:
the gates, in the substantially light-not-passing state, refract, reflect, diffract, diffuse, steer, filter, switch, re-direct, or block light.

[c26] 26. The apparatus of claim 15 , wherein:
one or more of the gates include a holographic optical element.

[c27] 27. The apparatus of claim 26 , wherein:
one or more of the gates include a volume phase hologram.

[c28] 28. The apparatus of claim 26 , wherein:
one or more of the gates include an electronically switchable Bragg grating.

[c29] 29. The apparatus of claim 15 , wherein:
the one or more biological probe array substrates includes a wafer.

[c30] 30. The apparatus of claim 15 , wherein:
the one or more biological probe array substrates includes a plurality of probe array substrates on a single wafer.

[c31] 31. The apparatus of claim 15 , wherein:
the one or more biological probe array substrates includes a plurality of wafers, each having a plurality of probe arrays.

[c32] 32. The apparatus of claim 15 , further comprising:
a first interface that aligns ends of the optical transfer elements with the light beam so that portions of the light beam enter the ends.

[c33] 33. The apparatus of claim 15 , further comprising:
a second interface that aligns ends of the optical transfer elements with the substrate.

[c34] 34. The apparatus of claim 33 , wherein:
the second interface includes a grate having openings that receive the ends.

[c35] 35. The apparatus of claim 34 , wherein:
the openings include tapered portions.

[c36] 36. The apparatus of claim 34 , wherein:
the grate is manufactured using LIGA technology.

[c37] 37. The apparatus of claim 34 , wherein:
the grate is manufactured using polymethylmethacrylate resist technology.

[c38] 38. The apparatus of claim 15 , further comprising:
a flow cell constructed and arranged to receive reagents and to dispose the reagents in relation to the substrate.

[c39] 39. The apparatus of claim 38 , wherein:
the substrate is disposed entirely within the flow cell and the flow cell includes a transparent portion constructed and arranged to enable light to reach the substrate.

[c40] 40. The apparatus of claim 38 , further comprising:
a flow cell controller that selectively provides reagents to the flow cell.

[c41] 41. The apparatus of claim 40 , wherein:
the reagents include nucleic acids, amino acids, or saccharides.

[c42] 42. An apparatus, comprising:

a light beam source that provides a light beam;

a plurality of optical fibers or optical fiber bundles, each comprising a first segment having first and second ends and a second segment having first and second ends, wherein the first ends of the first segments are disposed to receive at least portions of the light beam provided by the light beam source and to pass the portions through to the second ends of the first segments;

a plurality of addressable gates having inputs and outputs and constructed and arranged to selectively switch between substantially light-passing and substantially light-not-passing states, wherein the second ends of the first segments are optically coupled to the gate inputs and the first ends of the second segments are optically coupled to the gate outputs; and

one or more biological probe array substrates disposed to be capable of receiving light passed from the first ends of the second segments to the second ends of the second segments when the addressable gates are in the light-passing state.

[c43] 43. A system, comprising:

(1) a computer having

(a) a processor, and

(b) a memory unit having stored therein a manufacturing control application that, when executed by the processor, provides gating data; and

(2) an apparatus coupled to the computer, comprising

(a) a plurality of optical transfer elements,

(b) a light beam source that provides a light beam to the optical transfer elements,

(c) a plurality of gates constructed and arranged to selectively switch the optical transfer elements between substantially light-passing and substantially light-not-passing states in response to the gating data, and

(d) one or more biological probe array substrates disposed to be capable of receiving light from the optical transfer elements.

[c44] 44. The system of claim 43 , wherein:

the light beam source includes an ultra-violet radiation source.

[c45] 45. The system of claim 43 , wherein:

the optical transfer elements comprise a single optical fiber, one or more segments of single optical fibers, a bundle of optical fibers, one or more segments of bundles of optical fibers, or one or more optical gates.

[c46] 46. The system of claim 43 , wherein:

one or more of the plurality of optical transfer elements comprises first and second segments, each having an end optically coupled to a gate.

[c47] 47. The system of claim 43 , wherein:

one or more of the gates include a holographic optical element.

[c48] 48. The system of claim 43 , further comprising:

a flow cell constructed and arranged to receive reagents and to dispose the reagents in contact with the substrate.

[c49] 49. The system of claim 48 , wherein:

the substrate is disposed entirely within the flow cell and the flow cell includes a transparent portion constructed and arranged to enable light to reach the substrate.

[c50]

50. A system, comprising:

(1) a first computer constructed and arranged to process customer orders for synthesized probe arrays to provide probe and array configuration data indicative of at least one probe array sequence;

(2) a second computer, comprising

(a) a processor, and

(b) a memory unit having stored therein (i) a probe array design application that, when executed by the processor, processes the probe and array configuration data to provide probe array design data, and (ii) a manufacturing control application that, when executed by the processor, processes the probe array design data to provide gating data; and

(3) an apparatus coupled to the computer, comprising

(a) a plurality of optical transfer elements,

(b) a light beam source that provides a light beam to the optical transfer

elements,

(c) a plurality of gates constructed and arranged to selectively switch the optical transfer elements between substantially light-passing and substantially light-not-passing states in response to the gating data, and

(d) one or more biological probe array substrates disposed to be capable of receiving light from the optical transfer elements.

[c51] 51. The system of claim 50, wherein:

the first computer receives customer orders over the Internet.

[c52] 52. A method, comprising the steps of:

(1) processing customer orders for synthesized probe arrays to provide probe and array configuration data indicative of at least one probe array sequence;

(2) processing the probe and array configuration data to provide probe array design data;

(3) processing the probe array design data to provide gating data;

(4) directing a light beam to a plurality of optical transfer elements;

(5) selectively switching the optical transfer elements between substantially light-passing and substantially light-not-passing states in response to the gating data; and

(6) disposing light passed through optical transfer elements in the substantially light-passing state onto the one or more substrates.

[c53] 53. One or more arrays of biological probes disposed on one or more substrates, wherein the arrays are synthesized by a method comprising the steps of:

(1) directing a light beam to a plurality of optical elements;

(2) selectively switching the optical elements between substantially light-passing and substantially light-not-passing states in response to gating data; and

(3) disposing light passed through optical elements in the substantially light-passing state onto the one or more substrates.

[c54] 54. The arrays of claim 53, wherein the method further comprises the steps of:

(4) processing customer orders for synthesized probe arrays to provide probe

and array configuration data indicative of at least one probe array sequence;

(5) processing the probe and array configuration data to provide probe array design data; and

(6) processing the probe array design data to provide the gating data.